HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII

Under the joint supervision of the
UNIVERSITY OF HAWAII
and the
UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 73

CANE MOLASSES AS A FEED FOR DAIRY COWS

By
L. A. HENKE, Animal Husbandman

Issued November, 1934

Published by the
UNIVERSITY OF HAWAII
Honolulu, T. H.

HAWAII AGRICULTURAL EXPERIMENT STATION
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(Under the joint supervision of the University of Hawaii, and the Office of Experiment Stations, United States Department of Agriculture).

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CONTENTS

INTRODUCTION

The manufacture of 1 ton of cane sugar results, under average conditions, in the production of about 450 pounds of cane molasses. In Hawaii with an average annual production of about 1,000,000 tons of sugar, about 225,000 tons of cane molasses are produced annually. Much of this is exported, some is used as fertilizer, and some is fed to plantation work animals and to a lesser extent to other forms of livestock.

About three fourths of the molasses shipped away from Hawaii becomes a component part of mixed feeds and in this form some of it is shipped back to Hawaii.

During the year 1933, Hawaii imported livestock and poultry feed valued at about $1,600,000 and exported about 50,000

[1] The writer wishes to acknowledge the valuable help of M. Maneki and G. W. H. Goo, Assistants in Animal Husbandry, in compiling the results of these experiments. Much credit is also due to the workers in the Hawaii Experiment Station Dairy, whose faithful attention to detail makes experimental work of this kind possible.

tons of cane molasses valued at about $250,000. Since cane molasses when exported brings only about $5 per ton at present and when fed may be used to partially replace imported feeds averaging about $30 per ton, it seems desirable to feed as much of the locally produced cane molasses as may be practical. The purpose of the present investigation was to determine whether and to what extent, cane molasses can be substituted for imported products in the feeding of dairy cattle.

WORK OF OTHER INVESTIGATORS

Many experiments on the feeding of beet molasses were conducted in Europe a few years prior to 1900 when beet molasses was very cheap, but because the work was done with beet rather than cane molasses these investigations are not reviewed here.

Lindsey, Holland, and Smith *(8)*[1] in 1907 in a test with 2 lots of 3 dairy cows each, compared Puerto Rico molasses with cornmeal. When nearly 4 pounds of either molasses or cornmeal were included in the rations, they found that the cornmeal ration produced about 10 per cent more milk. Feeding molasses did not result in any undesirable flavor in the milk. They observed that molasses feeding caused a darker colored and softer feces than resulted from feeding cornmeal.

Woodward and Lee *(14)* in 1908 fed blackstrap molasses in amounts ranging from 0.5 to 0.7 pounds to calves ranging in age up to 7 months. This quantity produced scouring in these calves and, since an equivalent quantity of granulated sugar as that contained in the molasses produced the same scouring when fed to calves, they concluded the laxative effect was due to the sugar rather than to any other constituents of the molasses.

Grisdale *(6)* in 1913 substituted cane molasses in varying percentages for the mixture (6 parts bran, 3 parts gluten meal, 2 parts cottonseed meal, 2 parts dried brewer's grains) fed to dairy cows. At 10 percent the cane molasses proved quite satisfactory, increasing the palatability of the ration. At 20 percent the cows dropped in milk flow but this quantity, from 1½ to 2 pounds per day, caused the cows to gain in weight and condition. When molasses replaced the meal to the extent of 30 percent, there was a marked decrease in milk production. This quantity of molasses slightly scoured the cows and caused a loss in body weight.

Archibald *(1)* in 1914 in comparing molasses meals with molasses as feeds for dairy cows, concludes that molasses appeared more palatable and was a better and more economical milk producer.

Brintnall *(2)* in 1921 compared cane molasses with corn for feeding dairy cows as well as calves from 3 to 6 months old. He concludes that both for milk production and calf feeding, cane molasses is, pound for pound, practically equal to corn.

Calloway *(3)* in 1921 fed blackstrap molasses to Jersey and Holstein dairy calves, beginning with 1 or 2 ounces when the calves

1 Italic numbers in parentheses refer to literature cited, p 16.

were several weeks old and increasing the molasses till at 5 months some of the calves were getting 2 pounds per day. He concludes that blackstrap molasses is a safe feed for young calves in the amounts indicated, is not laxative when fed with grain, is a good appetizer, and keeps the calf in good condition.

Woodward, Converse, Hale, and McNulty *(13)* in 1924 added from 1.1 to 1.5 pounds of cane molasses to dairy cow rations that already were more than sufficient to maintain production according to feeding standards. This resulted in increased consumption and slightly increased milk production, but not sufficient to pay for the cost of the extra feed consumed. In another test where 1.1 pounds of hominy feed were replaced by an equal weight of molasses, a decreased milk flow but a slight increase in body weight resulted.

Nelson, Heller, and Fulmer *(9)* in 1925, experimenting with rats, found cane molasses to be richer in vitamin B than either beet or sorghum molasses. They found yeast to be richer than cane molasses in vitamin B, but the molasses was better for the rearing of young rats.

Williams *(12)* in 1925 investigated the effect of a basal ration containing no molasses and rations containing 15 and 25 percent cane molasses respectively on the digestibility of the total ration when fed to dairy cows. Much irregularity in the effect of the different amounts of molasses resulted with different cows in different experiments. He concludes that the digestibility of the crude fiber, nitrogen-free extract and ether extract were not uniformly affected by adding molasses but that molasses tended to slightly lower the digestibility of the crude protein and dry matter.

Ellison and Catala *(5)* in 1928 supplemented the grain ration for one group of cows with cane molasses and the other with corn chops (ground corn and by-products). The roughage for these cows consisted largely of sugar cane tops. The corn chop fed lot consumed more feed and produced more milk, but the greater economy in cost of milk production resulted when the molasses was added to the ration.

Roadhouse and Koestler *(10)* in 1929 showed that normal milk, which was relatively high in lactose and relatively low in chlorides, had a sweet pleasing taste, while milk in which the proportion of lactose and chloride was reversed had an unpleasant taste. They determined that adding molasses in amounts up to 6 pounds daily to the basal grain and alfalfa ration did not increase the lactose content of the milk.

Taylor and Nelson *(11)* in 1929 found that the addition of crude cane molasses to a synthetic vitamin E free diet furnished a good source of the vitamin on a 3 percent level. On a 5 percent level, 92 percent of the young were successfully weaned as compared with 58 percent on a 3 percent level.

Krauss *(7)* in 1930 found that cane molasses as a supplement to milk produced excellent growth, prevented nutritional anemia, and

was of value for hemoglobin regeneration in anemia. Beet molasses did not prevent anemia and had no beneficial effects on rats suffering from nutritional anemia. Chemical analysis showed that the cane molasses contained larger quantities of iron and copper than did the beet molasses.

Dickens (4) in 1931 found that blackstrap molasses fed at a level of 0.25 mg. proved more effective than calves liver, fed at the same level, in restoring hemoglobin in rats rendered anemic by milk feeding.

NEED FOR FURTHER WORK INDICATED

This review of molasses feeding experiments to dairy calves and cows presents a picture which is not wholly favorable, nor yet wholly unfavorable, to the use of molasses as a feed for dairy cows. The results secured by some investigators are almost contradictory to those secured by others. In view of this, and because of the importance of more definite and exact information on this subject to Hawaii dairymen, it seemed desirable to do more experimental work on this question.

Conditions in Hawaii are markedly different from those obtaining in many regions where dairying is an important industry. There, grain prices are generally as low or lower than the cost of cane molasses; in Hawaii grain prices are very high and cane molasses, especially to dairies favorably located near a sugar mill, costs very little.

GENERAL PLAN OF PRESENT EXPERIMENTS

The experiments to be reported here include a long time experiment which involved feeding cane molasses to many of the individual cows in the University herd for a period of 7 consecutive years to note accumulative effects, if any, on milk production and reproductive efficiency, and 2 short time experiments of 15 weeks each to note effects on production under better controlled conditions than is possible in a long time experiment.

THE LONG TIME EXPERIMENT

The long time experiment was started in July, 1924. After some preliminary cane molasses mixtures had been made and tried over a period of 1 month, a mixture containing 25 percent cane molasses (salt and raw rock phosphate in the mixture were not included in calculating percentage composition) was made on July 18, 1924 and fed continuously to many of the cows in the herd over a 7 year period to July 1, 1931.

For the purpose of controls, the records of these molasses-fed cows and others were examined during years preceding and/or following the molasses period when these cows were fed a mixture containing no molasses known as the X-mixture.

The fiscal year (July 1—June 30) rather than the lactation is

the basis of the summarized data presented below. Since this experiment covered such a long time (13 years), it was felt this was the only practical way of handling the data.

THE FEED MIXTURES

The concentrate feed mixtures fed, the nutrients they supplied, and their present cost (September, 1934) are as follows:

TABLE 1

THE CONCENTRATE FEED MIXTURES
X-RATION (NO MOLASSES)

		Digestible Crude Protein lbs.	Digestible Total Nutrients lbs.	Cost Sept. 1934
75 lbs.	barley	6.75	59.55	$ 1.61
50 "	cornmeal	3.75	42.85	1.30
100 "	wheat bran	12.50	60.90	1.65
10 "	coconut oil cake meal	1.99	7.08	0.15
5 "	linseed oil cake meal	1.58	3.79	0.11
3 "	raw rock phosphate	--------	--------	0.06
3 "	salt	--------	--------	0.02
246 "	mixture	26.57	174.17	$ 4.90
100 "	"	10.80	70.80	1.99

MOLASSES RATION (CONTAINING 25 PERCENT CANE MOLASSES)

		Digestible Crude Protein lbs.	Digestible Total Nutrients lbs.	Cost Sept. 1934
60 lbs.	wheat bran	7.50	36.54	$ 0.99
60 "	cane molasses	.60	35.70	0.30 [1]
80 "	cornmeal	6.00	68.56	2.08
20 "	soybean oil cake meal	7.94	16.90	0.42
15 "	coconut oil cake meal	2.98	10.92	0.22
5 "	linseed oil cake meal	1.59	3.79	0.11
3 "	raw rock phosphate	--------	--------	0.06
3 "	salt	--------	--------	0.02
246 "	mixture	26.61	172.41	$ 4.20
100 "	"	10.82	70.09	1.71

It will be noted that these feed mixtures, while quite different, supply the same amount of digestible protein and digestible total nutrients and carry the same amounts of added minerals. This ration is balanced when fed with green roughages that include considerable quantities of green alfalfa. If legume roughages were not included it would be somewhat low in protein for heavy producing cows.

The rock phosphate used was a high grade rock secured from the island of Makatea, carrying 36 percent P_2O_5 and only 2.4 percent fluorine. This rock has been fed for many years in Hawaii and examination of the teeth and general health of the cows gives no evidence of the harmful effects that were noted at several mainland experiment stations from feeding rock phosphate with a higher fluorine content.

The molasses was mixed with the grains each day at feeding

[1] Does not have a standard price. Can often be purchased at plantations for $5 per ton plus hauling costs.

time. Sometimes it was necessary to add some water to the molasses to reduce its viscosity to a point so that it could be properly mixed with the grain. The mixture resulting was somewhat sticky. For large scale feeding a mechanical mixer for thoroughly incorporating the molasses with the grain is desirable.

SIGNIFICANCE AND DESCRIPTION OF DATA SHOWN IN TABLE 2

The summary of the data on production and feed consumption as well as reproductive efficiency given in Table 2, which follows, covers all cows in the experiment from July 1, 1920 to July 1, 1933, a period of 13 years. During the first 4 years, from 1920 to 1924, and the last 2 years, from 1931 to 1933, only the X-ration was fed. During the 7 year period, from 1924 to 1931, most of the cows were fed the 25 percent cane molasses ration.

The experiment includes a total of 299 cow years or an average of 23 cows each year during the 13 years of the experiment. Separated according to feeds fed, the experiment includes 153 cow years on the molasses feed and 146 cow years on the control or X-feed mixture.

Of the 89 different cows, only 32 were on both the X-ration and the molasses feed and their records are perhaps of greatest value. The data from these cows are separately summarized. Besides these, however, 22 cows received only the molasses feed and 35 other cows received only the X-feed. Their summarized records are also given because their numbers seem large enough that data from them should have some significance even though there are no controls in the case of these cows on one feed only.

Separated according to breeds, the experiments included a total of 66 Holstein and 23 Guernsey cows, the Holsteins totalling 229 cow years and the Guernseys 70 cow years on this test.

The summarized table which follows is based on other tables showing records for each cow for each year and averages for each cow on each feed, but since these tables showing records of each individual cow during this long period are necessarily long and detailed, it seemed that merely presenting a summarized table would better serve the needs of the average reader.

The headings of the columns for the most part are self-explanatory, but a few descriptive words about some of them may be helpful.

Average period in milk during year. This means the average actual number of days during the year when the cows were producing milk.

Average milk produced per year. The data given show the average production during the years when on the indicated feed. No age correction factors have been applied to the milk yields.

Average percentage of fat. Composite samples from four consecutive milkings (2 days) were tested once each month for each cow. The average for the year was secured by totaling the tests and

dividing by the number of tests made.

Average age corrected fat production. These figures are secured by multiplying the actual fat yields for each cow for each year by the correction factor[1] for the age at that year so as to bring all yields to what are known as mature equivalents or the supposed maximum production of the cow at maturity—usually 7 years.

Average pounds concentrates fed. These data are secured from the daily feed records of each cow and the term concentrates as used here includes the cane molasses fed in one of the mixtures and also beet pulp which was fed as a supplement.

Pounds of 4 percent F.C. milk produced per pound concentrates fed. This is computed by dividing the average pounds of 4 percent F.C. milk[2] produced by the average total concentrates consumed by each cow on each feed and was not limited to the period when the cow was actually producing milk. Cane molasses and beet pulp were considered concentrates. We consider this a very significant figure in evaluating the 2 different concentrate feed mixtures, since this figure is in no way influenced by the varying costs of the feeds in different years.

Reproductive efficiency. It is occasionally stated in Hawaii that the feeding of large quantities of molasses results in a lowered reproductive efficiency. The writer is not familiar with research work supportng this theory.

A major reason for the present investigation was to accumulate data on the relative reproductive efficiency of the cows when fed the molasses and the non-molasses rations. Some of the most significant data obtained in this study are those relating to normal calves born, abortions, and reproductive efficiency.

One hundred percent reproductive efficiency, as used here, means 1 calf born per cow in a 12-month period. Nine months of pregnancy were considered the equivalent of 1 calf and the percent reproductive efficiency was determined not merely by counting calves born during the period but also by noting the months of pregnancy each cow had at the beginning and/or end of each period and calculating reproductive efficiency on that basis. A 6-month abortion was counted as 6 months of pregnancy, and if there was no other pregnancy either at the beginning or end of the year in question, the reproductive efficiency for that year would be 6/9 or 66.7 percent. Similarly, a cow that was non-pregnant at the beginning of a given year and remained so till 2 months previous to the end of the year would have a reproductive efficiency of only 2/9 or 22.2 percent for the year. Also a cow bred July 1 with calf born April

[1] Missouri Agricultural Experiment Station Bul. 274 (1929).

[2] Illinois Agricultural Experiment Station Bul. 245 (1923) p. 577-621.

TABLE 2

SUMMARY OF MILK AND FAT YIELDS, FEED CONSUMED, AND REPRODUCTIVE EFFICIENCY

	Feed	No. of cows	No. of cow years	Average period in milk per year	Average milk produced per year	Average content of fat in milk	Average corrected fat production	Average concentrates fed annually	4 percent F.C. milk produced per pound concentrates fed	Reproductive efficiency
HOLSTEINS				days	pounds	percentage	pounds	pounds	pounds	percentage
Only cows fed both	Mol.	24	80	313	7152.2	3.53	269.22	4226	1.54	80.43
Mol. and X-feeds	X	24	49	300	7234.9	3.65	268.68	4171	1.61	74.21
All cows fed Mol.	Mol.	39	121	310	6848.2	3.46	256.25	4041	1.53	78.53
All cows fed X-feed	X	51	108	303	7370.3	3.48	270.11	4221	1.59	79.26
GUERNSEYS										
Only cows fed both	Mol.	8	15	308	5670.5	4.44	276.16	3890	1.52	65.93
Mol. and X-feeds	X	8	17	317	5255.0	4.72	267.03	3552	1.66	71.01
All cows fed Mol.	Mol.	15	32	305	5111.0	4.46	252.74	3661	1.45	61.47
All cows fed X-feed	X	16	38	308	4978.0	4.69	251.86	3680	1.49	81.52
HOLSTEINS AND GUERNSEYS										
Only cows fed both	Mol.	32	95	312	6918.2	3.67	270.31	4173	1.54	78.13
Mol. and X-feeds	X	32	66	304	6694.7	3.93	268.32	4012	1.62	73.38
All cows fed Mol.	Mol.	54	153	309	6484.9	3.67	255.52	3962	1.52	74.95
All cows fed X-feed	X	67	146	304	6747.6	3.80	265.36	4080	1.57	79.95

10, if bred again (pregnancy resulting) on June 1, would have 10/9 or 111.1 percent reproductive efficiency. Twins do not increase reproductive efficiency; pregnancy advanced or completed rather than number of calves born is the basis of the term "reproductive efficiency" as used here.

These reproductive studies exactly parallel the production studies and cover exactly the same period.

The records of the individual cows are summarized in Table 2, using the cow year as the basis of the summary. This method means that a cow on a given feed for 3 years has 3 times as great an influence on the summarized results as one on the indicated feed for only 1 year.

SUMMARY OF LONG TIME TEST

1. Days in Milk. Cows when fed the molasses ration averaged about 1 week more of milk production than when the X-ration was fed and in all cases averaged over 300 days in milk during the year. The smaller number of Guernseys, however, averaged a slightly longer production on the X-ration.

2. Milk Production. The average actual production for all cows was slightly higher (about 5 percent) on the X-ration. The Guernseys, however, produced more on the molasses mixture. If comparisons are limited to only those cows that were fed both feeds, the production was slightly higher (about 3 percent) on the molasses mixture. These differences are all so slight that these 2 feed mixtures can be considered of about equal value as far as milk production is concerned.

3. Percentage of Fat. The butter fat content of the milk was .13 percent higher when the X-ration was fed.

4. Age Corrected Butter Fat. When all the cow years are considered the fat production was about 4 percent higher on the X-ration. If limited to cows on both feeds, fat production was slightly higher on the molasses feed.

5. Concentrates and Roughages Fed. The average cow was fed about 2 tons of concentrates and 10 tons of green roughages (not shown in table) per year.

6. Milk Produced per pound of Concentrates Fed. Approximately 1½ pounds of milk were produced for each pound of concentrates fed during the year, the amount being slightly larger (about 3 percent) when the X-ration was fed.

7. Reproductive Efficiency. The average reproductive efficiency of the 89 cows for 299 cow years was 77 percent. When limited to cows on both feeds, the reproductive efficiency for the molasses and

X-rations respectively was 78 and 73 percent; for all cows on these feeds 75 and 80 percent respectively. The Guernseys had a better reproductive efficiency on the X-ration; the Holsteins, when limited to those on both feeds, on the molasses ration.

There were only 7 abortions during the 299 cow years included in this experiment. Four of them occurred while the cows were being fed the X-ration and 3 while being fed cane molasses.

In general the results of this experiment do not show any increased numbers of abortions or indicate any significant reduction in reproductive efficiency as a result of molasses feeding.

THE SHORT TIME EXPERIMENT

The long time test just described had its greatest value in determining the effect, if any, of continuous molasses feeding on reproductive efficiency. These 2 short time experiments, which follow, were conducted in order to compare milk and fat production on the X-ration (non-molasses) and the molasses ration under better controlled conditions than was possible in a test covering many years.

In each of these tests the double reversal system of feeding was followed. The cows were divided into 2 lots, A and B, as equally as possible, as shown in Tables 3 and 4. One lot was started on the 25 percent cane molasses ration, after 5 weeks was shifted to the X-ration (non-molasses), and after another 5 weeks was put back on the molasses ration again for the last 5 weeks of the experiment. The other lot was started on the X-ration, fed the molasses ration during the second 5-week period, and finished the experiment by being fed the X-ration again during the last 5 weeks. Thus each experiment consisted of three 5-week periods, and the feeds fed the first and last periods were the same in the case of each lot in each experiment. Only the last 4 weeks of each 5-week period were used in computing results, the first week being designed to accustom the cows to the change in feed. The cows in both lots in each period received the same quantity and quality of roughages and beet pulp. While the quantity of concentrates fed to each cow varied in proportion to her ability to produce, the quantity for each cow was so adjusted that the average of the amounts of concentrates fed the first and last periods (when they were on the same feed) was the same as that fed during the middle period (when the cows were fed the different concentrate mixture, either X or molasses, depending on which feed the lot was started). This was necessary in order to avoid a second variable, quantity of feed, in an experiment where the quality of the concentrate mixtures was being tested.

In computing results, the mean of the first and third periods of each lot was compared with the second or middle period, thus compensating for decreasing production due to advancing lactation.

THE FEED MIXTURES

The same feed mixtures used in the long time test and detailed in Table 1 of this bulletin were used in these two 15-week tests.

Roughages consisted of some green alfalfa, but for the most part the roughages were largely Sudan, Napier, Bermuda, and other miscellaneous grasses. Approximately 6 pounds of green roughages were fed daily for each 100 pounds that the cows weighed.

In addition to the roughages and concentrates, 2 pounds of beet pulp were fed daily to each cow. This beet pulp was soaked with water for 12 hours before feeding.

TABLE 3

THE COWS USED AND FEEDING SCHEDULES

Experiment I—Feb. 2 to May 18, 1931

	Cow No.	Breed	Age	Days since calving to Jan. 31, 1931	Date due to calve	Average of daily production on Jan. 21, 23, 1931
			years			pounds
Lot A	42	H	9.0	22	....	18.9
	65	H	6.0	130	9-27-31	29.7
	67	G	6.0	36	....	31.3
	83	H	4.0	63	....	26.5
	100	H	2.5	85	....	21.0
Average			5.5	67		25.5
Lot B	59	H	6.5	69	....	29.9
	72	H	5.0	141	10-31-31	20.9
	85	H	3.5	17	....	33.6
	96	G	3.0	65	....	17.9
	99	H	2.5	51	....	23.4
Average			4.1	69		25.1

Feeding Schedule

	Lot A					Lot B				
Cow No.	42	65	67	83	100	59	72	85	96	99
Inclusive dates 1931										
Feb. 2-Mar. 8	X	X	X	X	X	Mol.	Mol.	Mol.	Mol.	Mol.
Mar. 9-Apr. 12	Mol.	Mol.	Mol.	Mol.	Mol.	X	X	X	X	X
Apr. 13-May 17	X	X	X	X	X	Mol.	Mol.	Mol.	Mol.	Mol.

H—Holstein X—Control (non-molasses ration)

G—Guernsey Mol.—25 percent cane molasses ration

TABLE 4
THE COWS USED AND FEEDING SCHEDULES
Experiment II—Jan. 7 to Apr. 2, 1932

	Cow No.	Breed	Age	Days since calving to Dec. 31, 1931	Date due to calve	Average of daily production on Dec. 12, 17, 22, 27, 1931
			years			pounds
Lot A	31	H	11.0	111	----	36.7
	60	H	7.0	76	----	21.2
	71	H	6.0	155	8-20-32	18.8
	82	H	5.0	118	9-11-32	26.4
Average			7.0	115		25.8
Lot B	68	H	6.0	79	----	35.5
	72	H	5.5	76	----	20.8
	74	H	5.5	76	----	27.1
	79	H	5.0	134	9-9-32	19.5
Average			5.5	91		25.7

Feeding Schedule

	Lot A				Lot B			
Cow No.	31	60	71	82	68	72	74	79
Inclusive dates 1932								
Jan. 7-Feb. 10	Mol.	Mol.	Mol.	Mol.	X	X	X	X
Feb. 11-Mar. 16	X	X	X	X	Mol.	Mol.	Mol.	Mol.
Mar. 17-Apr. 20	Mol.	Mol.	Mol.	Mol.	X	X	X	X

G—Guernsey   Mol.—25 percent cane molasses ration
H—Holstein   X—Control (non-molasses ration)

WEIGHTS OF COWS

All the cows were weighed at the beginning of the experiment and every week thereafter on the same day throughout the test. They were weighed in the afternoon after being fed and milked. The average weights of the different cows on the different feeds, as well as averages for the lots and the entire experiment for each feed, follow:

TABLE 5
AVERAGE WEIGHTS IN POUNDS
Experiment 1

	Lot A					Lot B				
Cow No.	42	65	67	83	100	59	72	85	96	99
Average Weight										
on X-ration	1007	918	1027	902	681	1020	793	943	855	778
on Mol. ration	1015	908	1005	923	705	1014	794	920	834	768

Lot A—Average weight on X-ration—907.0
" A— " " " Mol. " —911.2
" B— " " " X- " —877.8
" B— " " " Mol. " —866.0
Average weight all cows on X-ration—892.4
" " " " " Mol. " —888.6

TABLE 6
AVERAGE WEIGHTS IN POUNDS
Experiment II

	Lot A				Lot B			
Cow No.	31	60	71	82	68	72	74	79
Average Weight								
on X-ration	1260	1010	928	940	968	769	1064	843
on Mol. ration	1254	1004	942	1007	985	763	1060	815

Lot A—Average weight on X-ration—1034.5
" A— " " " Mol. " —1051.7
" B— " " " X- " — 911.0
" B— " " " Mol. " — 905.7
Average weight all cows on X-ration— 972.8
" " " " " Mol. " — 978.7

The averages given above are based on 12 weights made of each cow.

When the averages of these 2 experiments are averaged, we find that all the cows (18 cows, 216 weights) averaged 1 pound heavier when fed the molasses mixture.

Obviously, as far as weight of cattle is concerned, the molasses mixture is of equal value with the X-mixture with which it was compared.

BUTTER FAT CONTENT OF MILK

Composite samples of 4 consecutive milkings, taken on the same days each week, were tested in duplicate for butter fat content. Since the last 4 weeks of each period were used for computing results, 12 composite samples of the milk of each cow were tested. The averages of these tests on the different feeds follow:

TABLE 7
AVERAGE PERCENTAGE OF BUTTER FAT IN MILK
Experiment I

	Lot A					Lot B				
Cow No.	42	65	67	83	100	59	72	85	96	99
Average Test										
on X-ration	3.34	3.61	3.75	3.63	2.98	2.93	3.75	3.63	4.83	3.58
on Mol. ration	3.25	3.43	3.65	3.53	2.85	2.87	3.68	3.53	4.88	3.59

Lot A—Average percentage of fat on X-ration—3.46
" A— " " " " " Mol. " —3.34
" B— " " " " " X- " —3.74
" B— " " " " " Mol. " —3.71
Average percentage of fat all cows on X-ration—3.60
" " " " " " Mol. " —3.53

TABLE 8
AVERAGE PERCENTAGE OF BUTTER FAT IN MILK
Experiment II

	Lot A				Lot B			
Cow No.	31	60	71	82	68	72	74	79
Average Test								
on X-ration	3.50	3.45	3.75	4.15	3.65	3.33	3.54	3.90
on Mol. ration	3.62	3.20	3.43	4.14	3.50	3.57	3.62	4.12

Lot A—Average percentage of fat on X-ration—3.71
" A— " " " " " Mol. " —3.60
" B— " " " " " X- " —3.60
" B— " " " " " Mol. " —3.70
Average percentage of fat all cows on X-ration—3.65
" " " " " " Mol. " —3.65

In Experiment I, 8 of the 10 cows tested slightly higher on the X-ration, the average for all the cows being .07 percent in favor of the X-ration.

In Experiment II, 4 cows tested higher on the X-ration and 4 higher on the molasses ration, the averages for all cows for this experiment being the same.

When both experiments were averaged we found the average test on the X-ration was 3.63 percent and on the molasses ration 3.59 percent.

This difference, while slightly favorable to the X-ration, is so small that it probably has no significance.

MILK PRODUCTION, QUANTITY OF FEEDS FED, AND FEED COSTS

The following condensed table shows the milk yields, quantity of feeds fed, feed costs and unit feed costs for each experiment and for the averages of the two experiments. The details for each lot and for each cow in each lot are available, but since the results with both lots were essentially the same, only the average of the two lots for each experiment is given in Table 9.

TABLE 9

MILK PRODUCTION AND FEED COSTS

	Experiment I		Experiment II		Average of Experiments I and II	
	X-ration	Mol. ration	X-ration	Mol. ration	X-ration	Mol. ration
Average pounds milk produced per cow per day	20.8	20.5	24.13	24.53	22.46	22.51
Average pounds 4 percent F.C. milk produced per cow per four-week	542.2	539.0	640.5	650.4	591.3	594.7
Average pounds concentrates[1] fed per cow per day	12.4	12.1	12.35	12.39	12.37	12.24
Average total pounds concentrates fed per cow per four-week period	348.1	339.3	346.0	346.7	347.0	343.0
Average roughage cost per cow per day	$ .15	$ .15	$ .185	$ .185	$ .167	$ .167
Average feed cost[2] per cow per four-week period	$10.98	$10.42	$10.57	$10.05	$10.77	$10.23
Feed cost[2] per 100 pounds of 4 percent F.C. milk	$ 2.03	$ 1.93	$ 1.65	$ 1.55	$ 1.84	$ 1.74
Feed cost[2] per pound of butter fat produced	$ .532	$ .505	$ .428	$ .402	$ .480	$ .453
Pounds 4 percent F. C. milk produced per pound of concentrates fed	1.56	1.59	1.85	1.88	1.70	1.73
Pounds concentrates required to produce 1 pound butter fat	16.86	16.45	14.01	13.85	15.43	15.15

[1] Beet pulp was included as a concentrate in these experiments.

[2] Based on feed prices prevailing at the time these experiments were performed.

SAVING IN FEED COSTS DUE TO MOLASSES FEEDING

Of greatest interest is the saving in feed costs, if any, due to molasses feeding. Based on all feeds fed (concentrates and roughages), the saving due to molasses feeding was about 5 percent in the first experiment and 6 percent in the second test. This saving will vary with the prices of the feeds used in the mixtures. During the first experiment the cost of a ton of the X-mixture was $38.58; the cost of a ton of the molasses mixture was $35.04. In the second experiment the corresponding ton prices were $32.04 and $28.38. At present prices (September, 1934) the mixtures cost $39.80 and $34.20 per ton respectively. All these are based on an assumed value of $10 per ton for molasses. Should molasses be available at $5 per ton, the present cost of a ton of the molasses mixture would be $31.20. Should molasses be gratis, as is possible in sugar plantation dairies, the present cost of the molasses mixture would be $28.20 per ton.

If only the costs of the two mixtures being tested are considered, the percentage saving will be much greater than the 5 or 6 percent shown above, since the roughage and beet pulp fed constituted a considerable part of the feed cost and are the same for all cows. If the percentage of saving is based on the costs of the concentrate mixtures only, the saving will, for all practical purposes, be the percentage difference in the cost of the X- and molasses rations, since, as these experiments indicate, they produce about the same results. On that basis, the percentage saving from feeding the 25 percent cane molasses mixtures, which averaged about 10 percent during the time of the 2 short experiments, would be about 14 percent, based on present prices with cane molasses valued at $10 per ton. If molasses can be secured gratis, the saving in concentrate feed costs at present prices would be about 29 percent.

SUMMARY OF SHORT TIME TESTS

1. The cows when fed the molasses ration averaged 1 pound heavier than when the X-ration was fed.

2. The fat content of the milk averaged 3.63 and 3.59 percent for the X- and the molasses rations respectively.

3. Average daily milk production was 22.46 and 22.51 pounds for the X- and molasses rations respectively.

4. With molasses valued at $10 per ton, the saving in concentrate feed costs due to feeding molasses was about 14 percent at September, 1934 feed prices. On plantations where molasses may be considered gratis the concentrate feed cost saving would be about 29 percent.

GENERAL SUMMARY OF LONG AND SHORT TIME EXPERIMENTS

1. Hawaii annually imports livestock feeds valued in excess of $1,000,000.

2. Hawaii annually produces nearly 250,000 tons of cane molasses as a by-product of the manufacture of sugar, of which only about 5 percent is locally used for feeding livestock.

3. Work at this station and elsewhere shows that at prices prevailing in Hawaii a much larger amount of this cane molasses should be utilized for livestock feeding.

4. Experiments reported in this bulletin indicate that when properly supplemented with high protein feeds cane molasses may be safely substituted for 25 percent of the other concentrates fed to dairy cows.

5. At prices prevailing in Hawaii at present (September, 1934), such substitution would result in a saving of about 14 percent in the cost of the concentrate feed fed to dairy cows when molasses is valued at $10 per ton. If molasses is gratis, as may occur on some plantation dairies, the saving would be about 29 percent.

6. The long time experiment detailed in this bulletin does not show any significant reduction in reproductive efficiency or increased abortions resulting from feeding a concentrate mixture containing 25 percent cane molasses. In 153 cow years when molasses was fed we experienced 3 abortions; in 146 cow years on the non-molasses ration there were 4 abortions.

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